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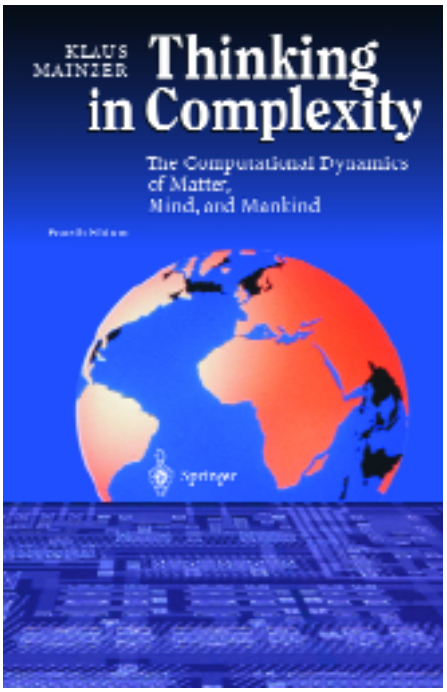
BOOKS

Thinking in Complexity: The Computational Dynamics of Matter, Mind, and Mankind, 4th ed.
Klaus Mainzer
Springer-Verlag, Berlin, Heidelberg, New York, 2004
456 pp.
ISBN 3-540-00239-1

Reviewed by Anutosh Moitra



The science of complexity is likely to be among the most salient features of the 21st century, and *Thinking in Complexity: Computational Dynamics of Matter, Mind, and Mankind* is just as likely to be among the most popular introductions to the topic. Author Klaus Mainzer treats highly technical materials related to descriptions of complexity pervading science, engineering, societal dynamics—and even ethics—with a lucidity that is sure to captivate physicists as well as the general public with a moderate scientific background.

The central premise of the book regards complexity as emergent phenomena—structure, chaos, phase transition, and so on. These phenomena arise out of nonlinear interactions augmented by dissipation and constrained by a requirement of balance between the two. Macroscopic patterns curdle out of the soup of nonlinear interactions between microscopic components of a system. Mainzer extends this concept to encompass such diverse subjects as classical and quantum physics, dynamic systems, evolution of life and organisms, cellular automata and networks, artificial intelligence, economics, and social and cultural systems, and he finishes with a chapter of speculations on how the science of complexity will inform humankind's roles, responsibilities, and ethics in the future.

Readers of this book will enjoy Mainzer's exposition, which is based on a tight coupling between classical and historical concepts from Plato and Aristotle to modern, mathematical and physical developments, including relativity, chaos, and quantum physics. Every chapter begins with a section designed to orient the reader to the perspective of philosophical developments through the ages pertinent to the topic at hand. Readers with the patience to read between the lines will be rewarded with occasional gems such as Mainzer's speculation on a possible correlation between a society's development of atomistic ideas and its possession of a phonetic alphabet. The author takes pains to point out essential differences between classical science and the science of complexity. Simple forecasting or prediction is neither possible nor warranted in complexity studies. One must execute all the minute steps of a complex process to arrive at a particular end result, which is just one of multiple possible futures. The goal of thinking in complexity is to better understand the process and the system.

The chapters on societal-cultural complex phenomena are particularly intriguing. An economic system has at its microcomponent level individuals with self-interests and egoistic intentions. Aggregate market behavior appears at a macro level. Dissipation mechanisms are supplied to this nonlinear interactive process by obvious means—political or economic friction. Mainzer extrapolates from this reasoning the idea that ethics, in the sense of a way to attain the greatest good, is not determined by individual abilities or advantages but evolves by a stream of complex, nonlinear, and random processes. *Thinking in Complexity* is an outstandingly readable book.

Anutosh Moitra is a principal engineer at Boeing in Seattle, Washington, and works in the field of computational fluid dynamics (anutosh.moitra@pss.Boeing.com).

The Space Environment: Implications for Spacecraft Design (revised and expanded edition)
Alan C. Tribble
Princeton University Press, Princeton, N.J., 2003, 232 pp.
ISBN 0-691-10299-6

Reviewed by Henry J. P. Smith

The Space Environment: Implications for Spacecraft Design gives a broad overview of a number of physical disciplines that need to be dealt with in the design of any space mission. The author, Alan C. Tribble, is an executive with a well-known U.S. aerospace company and has taught courses in the subject both in universities and at professional meetings. First printed in 1995, this revised edition includes some information developed during the intervening years.

It is of course obvious that space is an environment quite different from our everyday experience, but one does not realize just how alien it is until one starts to think of the details included in this volume. Tribble employs some basic physical concepts to introduce the material of each chapter, using equations that ought to be accessible to most undergraduates in physical science and engineering. It is always interesting to see how far one can get with quite simple concepts, and Tribble carries this out rather well. Some of these could be useful for motivating students with topical issues, such as the Columbia shuttle disaster.

The text covers five distinct environmental factors that can affect the performance of spacecraft: vacuum, the extremely low pressure encountered by a spacecraft and its instrumentation; neutral, the residual atmosphere at various orbital altitudes; plasma, produced by the charged particles in space itself; radiation, the high-energy charged particles and photons in the background; and finally, micrometeoroid/orbital debris, which may cause kinetic damage to a space vehicle or its instruments. Each subject forms a separate chapter so a reader

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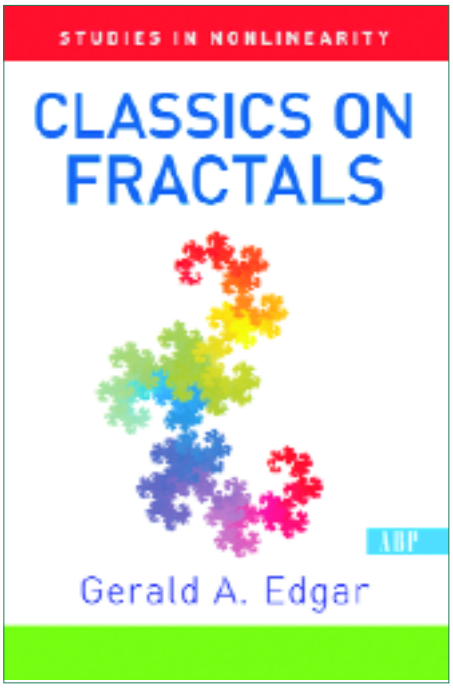
may use the book to review what issues need to be addressed in planning a particular space experiment or mission for any one of these design issues. Each chapter provides a number of exercises and a fairly extensive bibliography, which will be needed by anyone considering these issues for an operational design. As might be expected, most of the referenced papers and books are from the engineering literature, with the American Institute of Aeronautics and Astronautics' *Journal of Spacecraft and Rockets* cited most often.

I did note several apparent minor errors in the text. For example, in the first chapter, Tribble presents an equation to illustrate the basic nuclear fusion reactions in the sun, a subject of only peripheral interest to the remainder of the book. This equation was wrong in the first edition and has not been corrected in the new one. In fact, the nuclear reaction chain in the sun is more complex than a single reaction can describe. Also, in discussing the cosmic radiation background, Tribble uses a figure that has the atomic number Z as a parameter, but he never clearly defines what Z is. There are also a number of grammatical and stylistic issues that I found jarring, such as referring to the "Aurora australialis" instead of the correct "australis."

I found the book useful overall. The author's style keeps the reader interested in spite of the few minor faults mentioned. If one needs a good introduction to the issues that may arise in the design of an instrument for a space-based measurement, this would be a good place to start, but one will definitely need to follow up with more detailed references such as those the author provides. Those who are teaching undergraduate courses in science or engineering may find some useful examples in this book.

Henry J. P. Smith is a part-time lecturer in physics at Northeastern University in Boston. Semi-retired, he worked for more than 30 years in industry, in atmospheric and infrared physics, and he built large-scale computer codes for use in such studies (h.smith@neu.edu).



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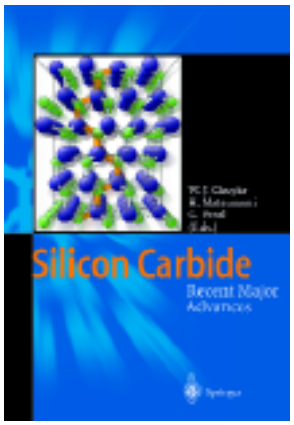

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